REMARKS

By this amendment, claims 1-6, 9-11, 14-15, 24, 26-62, 64-73 and 75-86 are pending in the application. Of these, claims 1, 10, 11, 24, 28, 32, 79-82 and 84 are being amended and claim 86 is being added. Claims 17-23 remain withdrawn. The amendments are fully supported by the originally filed specification and original claims and add no new matter. Entry of the amendments and reconsideration of the present case is respectfully requested.

Rejection Under 35 U.S.C. 103(a) of Claims 1, 2-6, 9-11, 14, 15, 24, 26-62 and 64-85

Krogh and Foster et al.

The Examiner rejected claims 1, 2-6, 9, 24, 31, 35, 39, 56-62, 74, 77, 79 and 80 under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent No. 5,453,125 to Krogh in view of U.S. Patent No. 5,567,243 to Foster et al. This rejection is traversed.

Claim 1 is patentable over Krogh and Foster et al. because Krogh and Foster et al. do not teach or suggest "(d) an exhaust tube through which the effluent may be flowed, the exhaust tube being adapted to provide a non-circuitous and non-turbulent flow of effluent therethrough by being substantially absent projections or recesses (i) that alter the flow direction of the effluent to provide a circuitous flow of effluent through the exhaust tube, and (ii) that cause turbulence in the flow of the effluent through the exhaust tube; and (e) an RF energy applicator to couple RF energy to the effluent in the exhaust tube to reduce the hazardous gas content of the effluent," as recited in the claim.

Krogh discloses a plasma chamber (1) having entrance and exit conduits (7 and 8), shown in Figure 1. However, Krogh does not disclose an apparatus that has both an exhaust tube that meets the criteria specified in part (d) of the claim, namely

that the tube is substantially absent projections and recesses, and that has the RF energy applicator recited in part (e) that is adapted to couple RF energy to effluent in the exhaust tube.

The plasma chamber disclosed by Krogh is not substantially absent projections and recesses, unlike the exhaust tube recited in the claim. Instead, the plasma chamber of Krogh is substantially square-shaped with square corners, as shown in Figure 1. These square corners are recesses that alter the flow direction of the effluent to provide a circuitous flow. This structure has been discussed and distinguished in the Background of the instant application, which states: "another problem with the conventional abatement chamber (12) is its square shape which includes corners and recesses that result in stagnant regions in which gas phase nucleations produce solid phase byproducts that deposit on the internal surfaces of the abatement chamber (12)." (Page 3, lines 1-8.) In contrast, the exhaust tube of claim 1 is "adapted to provide a non-circuitous and non-turbulent flow of effluent therethrough by being substantially absent projections or recesses ..." Thus, the plasma chamber of Krogh does not teach or suggest the recited exhaust tube.

The Examiner furthermore appears to refer to Krogh's entrance conduit (7) to reject the recited exhaust tube. However, Krogh does not teach or suggest an apparatus that couples energy to a gas that is in the entrance conduit. Instead, Krogh discloses that "microwave power supply (not shown) then generated microwaves which travel down the wave guide and enter the chamber through window 2." Thus, Krogh discloses coupling energy to a gas that is in the plasma chamber, and thus to a gas in a chamber having projections and recesses, but does not disclose coupling energy to gas in the entrance conduit. Accordingly, as Krogh does not teach or suggest an apparatus having an energy applicator that couples energy to a gas in an exhaust tube that is substantially absent projections and recesses, claim 1 and the claims depending therefrom are patentable over Krogh et al.

Furthermore, one of ordinary skill in the art would not have found it

obvious from the disclosure of Krogh to devise an apparatus having an exhaust tube substantially absent projections and recesses, and also having a gas energizer that couples energy to a gas in the tube. Krogh discloses that "In order to ensure that all feed gas species benefit from the special conditions in the ECR resonance surface it is desirable to force the gas through this resonance surface ...Thus, if the inlet port 7 is located below the ECR resonance surface, then the exit port 8 is located above the ECR resonance surface, and vice versa" (column 7, lines 14-22), where the ECR resonance surface is "roughly parallel to the top and bottom of the chamber" (column 6, line 51.) Thus, Krogh discloses the desirability of coupling energy to the plasma chamber having the square-like shape shown in Figure 1, with the inlet port and exit port above or below one another, because the chamber shape and configuration forces the gas to flow through the ECR resonance surface. Accordingly, one of ordinary skill in the art would not have found it obvious, based on the teachings of Krogh, to devise an apparatus that couples energy to a gas in the claimed exhaust tube that is substantially absent projections or recesses, and claim 1 and the claims depending therefrom are patentable over Krogh.

Foster et al. does not make up for the deficiencies of Krogh because Foster et al. also does not teach or suggest the exhaust tube and energy applicator recited in the claim. Foster et al. discloses "a microwave plasma source for generating an upstream reactant gas plasma from which the necessary radicals are drawn" (column 8, lines 10-12) to process a substrate in a downstream reactor. Thus, Foster et al. discloses a source that provides an energized gas to a process chamber, but Foster et al. does not teach or suggest an exhaust tube through which effluent from a process chamber is exhausted, and that is substantially absent projections or recesses, as recited in the claim. Foster et al. also does not teach or suggest an energy applicator that couples energy to gas in an exhaust tube to reduce the hazardous gas content. Furthermore, Foster et al. does not teach or suggest any benefits of coupling energy to an effluent gas in an exhaust tube, such as reducing a hazardous gas content of the gas. Thus, as Krogh et al. does not teach or suggest coupling energy to gas in an exhaust tube substantially absent projections or recesses, and Foster et al. does not

teach or suggest coupling nergy to an exhaust tube, claim 1 and the claims depending therefrom are patentable over Krogh and Foster et al.

Claim 24 is patentable over Krogh and Foster et al. because Krogh and Foster et al. do not teach or suggest "a monocrytalline sapphire exhaust tube through which the effluent may be flowed, the exhaust tube being substantially absent projections or recesses," as recited in the claim.

Krogh discloses "microwave window 2 made of microwave transparent material like quartz or aluminum oxide" (column 5, lines 40-41.) Thus, Krogh discloses a window made of aluminum oxide, but does not teach or suggest forming an exhaust tube from monocrystalline sapphire. As described in the specification in the paragraph bridging pages 9 through 10, monocrystalline materials are not the same as conventional ceramic materials, such as aluminum oxide, because "large crystals within monocrytalline sapphire typically have an average diameter of about 0.5 to about 10 cm" whereas conventional polycrystalline materials have "small grains or crystals with diameters on the order of 0.1 micron to 50 micron." The monocrystalline sapphire is furthermore distinguished from polycrystalline materials because the large crystals in the monocrystalline sapphire "are oriented substantially in the same crystallographic direction, and provide exposed surfaces having little or no impurity or glassy grain boundary regions that can erode." Krogh does not teach or suggest the advantages of monocrystalline sapphire, and thus a moncrystalline sapphire exhaust tube is not obvious from Krogh's disclosure of an aluminum oxide window. Furthermore, Krogh et al. does not teach or suggest any advantages of forming an entire exhaust tube from monocrystalline sapphire, such as in providing a smooth internal surface absent projections and recesses, and instead only discloses forming a transparent window portion of a plasma chamber from aluminum oxide. Foster et al. does not make up for the deficiencies of Krogh because Foster et al. also does not teach or suggest a monocrystalline sapphire exhaust tube. Accordingly, claim 24 and the claims depending therefrom are patentable over Krogh and Foster et al.

Claim 74 was canceled in a previous response and is no longer pending in the application. Thus, the rejection of this claim is obviated.

Claim 79 is patentable over Krogh and Foster et al. because neither of the references teaches or suggests "(d) an exhaust tube through which the effluent may be flowed, substantially the entire internal flow surface of the exhaust tube being parallel to a single direction of the flow of the effluent through the exhaust tube; and (e) a microwave energy applicator to couple microwaves to the effluent in the exhaust tube to reduce the hazardous gas content of the effluent," as recited in the claim. Krogh et al. discloses a square-shaped plasma chamber which also has a square shaped internal surface, as shown in Figure 1. Since portions of this internal chamber surface, such as the ceiling, are perpendicular to other portions of the internal surface, such as the walls, the entire internal flow surface of the exhaust tube is not parallel to a single direction of flow of the effluent through the exhaust tube, as in the claimed tube. Furthermore, Krogh does not teach or suggest an energy applicator to couple microwaves to such a tube, and instead discloses coupling energy to the square-shaped plasma chamber. Accordingly, Krogh does not teach or suggest the exhaust tube or energy applicator recited in the claim.

Foster et al. discloses a microwave plasma source to provide an energized reactant to a reactor, but does not teach or suggest coupling energy to a gas in an exhaust tube, and also does not teach or suggest an exhaust tube having the internal surface that is parallel to a single direction of the flow of effluent. Accordingly, as neither Krogh or Foster et al. teach or suggest coupling energy to an exhaust tube having the internal flow surface recited in claim 79, claim 79 and the claims depending therefrom are patentable over Krogh in view of Foster et al.

Claim 80 is also patentable over Krogh and Foster et al. because neither of the references teaches or suggests "(d) an exhaust tube through which the effluent may be flowed, the exhaust tube comprising an inlet and an outlet that are substantially facing each other in an opposing relationship; and (e) a microwav en rgy applicator to

couple microwaves to the effluent in the exhaust tube to reduce the hazardous gas content of the effluent," as recited in the claim.

As discussed above, Krogh discloses an inlet conduit 7 that is located below an exit conduit 8 in the plasma chamber, as shown in Figure 1. Thus, the inlet and exit conduits of Krogh are not facing each other in an opposing relationship, as the conduits are vertically separated along the plasma chamber wall. Krogh furthermore discloses that the configuration of the inlet an exit conduits shown in Figure 1 is desirable because it can "force the gas through the resonance surface" (column 7, line16) to "ensure that all feed gas species benefit from the special conditions in the ECR resonance surface" (column 7, lines 14-15.) Thus, Krogh teaches away from providing a tube with an inlet and outlet that are substantially facing each other in an opposing relationship, as in the tube of claim 80. Krogh also does not teach or suggest an applicator to couple energy to such an exhaust tube.

Foster et al. does not make up for the deficiencies of Krogh, because Foster et al. does not teach or suggest an exhaust tube having the recited inlet and outlet, and furthermore does not teach or suggest coupling energy to effluent in such an exhaust tube. Instead, as disclosed above, Foster et al. discloses a microwave plasma source that provides energized reactant to a reactor, but does not teach or suggest energizing effluent in an exhaust tube. Accordingly, claim 80 and the claims depending therefrom are patentable over Krogh in view of Foster et al.

Aoki and Krogh

The Examiner rejected claims 10, 11, 15, 26-30, 40-47, 49-55, 66-72, 75, 76, 78 and 81-85 under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent No. 5,352,902 to Aoki in view of Krogh. This rejection is traversed.

Claim 10 is patentable over Aoki and Krogh because neither of the references teaches or suggests "a computer controller system comprising program code

capable of monitoring the signal from the gas analyzer, determining whether the hazardous gas content of the effluent exceeds a safety level," as recited in the claim, and performing the recited operations if the hazardous gas content does exceed the safety level.

Aoki does not teach or suggest a computer controller system that determines whether a hazardous gas content in an effluent exceeds a safety level. Instead, Aoki discloses that "The control/computation unit 53 reads from a reference data memory 52 reference data indicative of an endpoint of etching, and compares the detection data with the reference data" (column 7, lines 25-28.) Thus, Aoki discloses a computation unit that compares to reference data to determine the endpoint of a process, but does not teach or suggest a controller system that can determine when a hazardous gas content exceeds a safety level, which is a level that is indicative of dangerously high amounts of hazardous gas according to industry accepted standards of gas toxicity. Determining the endpoint of a process by comparing to reference data is not the same as a determining whether a safety level has been exceeded, because the endpoint reference values are only representative of conditions at the completion of a process. The endpoint conditions do not require that a safety level has been exceeded, and the safety level may also be exceeded during processing at other times than the endpoint.

In contrast, to determine whether a safety level has been exceeded involves operations such as for example generating an "Effluent Gas Composition Table" for gases in the effluent, as described in the first full paragraph on page 23, and comparing the table with safety levels that are known to be dangerous levels of hazardous gas components. Accordingly, as Aoki does not teach or suggest comparing with known safety levels to determine whether the level has been exceeded, the controller system of claim 10 is patentable over Aoki. Furthermore, as Aoki is silent on the desirability of reducing a hazardous gas content of the effluent, one of ordinary skill in the art would not have found it obvious from the teachings of Aoki to devise a controller that determines whether a hazardous gas content exceeds a safety level, and

takes appropriate action to reduce the level, as with the recited controller.

Krogh does not make up for the deficiencies of Aoki because Krogh also does not teach or suggest the controller system that determines whether the hazardous gas content exceeds a safety level. As discussed above, Krogh discloses a plasma chamber to couple energy to a gas exhaust, but does not teach or suggest monitoring a hazardous gas content of the gas in the plasma chamber, or determining whether it exceeds a safety level. Accordingly, as Aoki and Krogh fail to teach or suggest the controller system that determines a safety level, claim 10 and the claims depending therefrom are patentable over Aoki and Krogh.

Claims 11, 26, 82, 83 and 85 are similarly patentable over Aoki and Krogh because neither of the references teaches or suggests a computer controller system comprising program code capable of "determining whether the hazardous gas content of the effluent exceeds a safety level," as recited in the claim. Instead, as discussed above, Aoki disclose determining an endpoint of an etching process, but does not teach or suggest determining whether a safety level has been exceeded. Krogh does not teach or suggest monitoring an effluent gas to determine a hazardous gas content. Accordingly, claims 11, 26, 82, 83 and 85 and the claims depending therefrom are patentable over Aoki in view of Krogh.

Claim 28 is patentable over Aoki and Krogh because neither of the references teaches or suggests a computer program product having "safety operational program code adapted to determine whether the hazardous gas content of the effluent exceeds a safety level," as recited in the claim. Instead, as discussed above, Aoki discloses determining an etching endpoint, and Krogh does not teach or suggest monitoring an effluent.

Claim 81 is patentable over Aoki and Krogh because the references do not teach or suggest "an RF energy applicator to couple RF energy to the effluent in the exhaust tube to n rgize the effluent ... and a computer controller system comprising

program code capable of monitoring the signal from the gas analyzer, and det rmining whether the hazardous gas content of the effluent exceeds a safety level, and if the hazardous gas content is determined to exceed the safety level, adjusting a power applied to the RF energy applicator to reduce the hazardous gas content in the effluent," as recited in the claim. As discussed above, neither Aoki or Krogh teach or suggest a controller system that determines whether a hazardous gas content exceeds a safety level.

Furthermore, the Aoki and Krogh do not teach or suggest adjusting a power applied to an RF energy applicator that couples energy to effluent in an exhaust tube to reduce the hazardous gas content, if is determined that the content exceeds the safety level. As the Examiner acknowledged on page 5 of the most recent Office Action, "Aoki does not teach a RF energy applicator to couple RF to the effluent flowing through the exhaust tube to reduce the hazardous gas content of the effluent." Thus, as Aoki does not teach or suggest coupling energy to effluent in an exhaust tube, Aoki et al also does not teach or suggest adjusting a power level applied to couple energy to effluent in the tube in response to a determination of whether the hazardous gas content exceeds a safety level. Krogh does not teach or suggest monitoring the hazardous gas content, and thus also does not teach or suggest adjusting a power level in response to a determination of whether the hazardous gas content exceeds a safety level. Accordingly, claim 81 and the claims depending therefrom are patentable over Aoki and Krogh.

Claim 84 is patentable over Aoki and Krogh because the references do not teach or suggest "a computer controller system comprising program code capable of monitoring the signal from the gas analyzer, and determining whether the hazardous gas content of the effluent exceeds a safety level that is indicative of dangerously high amounts of hazardous gas in the effluent, and if the hazardous gas content is determined to exceed the safety level, adding a reagent gas to the effluent before or after the effluent is energized, the reagent gas being added at a flow rate that is sufficiently high to reduce the hazardous gas content in the effluent," as recited in the

claim. As discussed abov , Aoki and Krogh do not teach or suggest a controller that can determine whether a hazardous gas content exceeds a safety level that is indicative of dangerously high amounts of hazardous gas.

Furthermore, neither Aoki or Krogh teach or suggest adding a reagent gas to the effluent if the hazardous gas content is determined to be too high. Aoki discloses that "reaction gases are fed from an etching gas source 20C or an ashing gas source 20B into the surface treatment device 1" (column 5, lines 51-53.) Thus, Aoki discloses feeding gases into a surface treatment device in which a substrate is processed, but does not teach or suggest adding a reagent gas to an effluent that has been exhausted from the surface treatment device. Furthermore, Aoki does not teach or suggest that the reaction gases fed into the surface treatment device are capable of reducing the hazardous gas content of the effluent. Accordingly, one of ordinary skill in the art would not have found it obvious, based on the teachings of Aoki, to add a reagent gas to an effluent in response to a determination that a hazardous gas content was too high.

Krogh discloses that effluent "is mixed with an appropriate reaction partner added through conduit 20," (column 7, lines 46-47.) However, Krogh does not teach or suggest monitoring a hazardous gas content of an effluent. Thus, Krogh also does not teach or suggest providing a flow rate of reagent gas that is sufficiently high to reduce the hazardous gas content, in response to a safety level determination. Accordingly, one of ordinary skill in the art would not have found it obvious from the teachings of Aoki and Krogh to devise a controller that provide a flow rate of reagent gas that was sufficiently high to reduce a hazardous gas content, in response to a determination that a safety level was exceeded. Thus, claim 84 and the claims depending therefrom are patentable over Aoki and Krogh.

Krogh, Foster et al. and Aoki

The Examiner rejected claims 11, 15, 26-30, 37, 38, 50-54, 64-66, 69-71, 76 and 78 under 35 U.S.C. 103(a) as being unpatentable over Krogh and Foster et al. in

view of Aoki. This rejection is traversed.

Claim 1, from which claims 37 and 38 depend, is patentable over Krogh, Foster et al. and Aoki because the references do not teach or suggest "(d) an exhaust tube through which the effluent may be flowed, the exhaust tube being adapted to provide a non-circuitous and non-turbulent flow of effluent therethrough by being substantially absent projections or recesses (i) that alter the flow direction of the effluent to provide a circuitous flow of effluent through the exhaust tube, and (ii) that cause turbulence in the flow of the effluent through the exhaust tube; and (e) an RF energy applicator to couple RF energy to the effluent in the exhaust tube to reduce the hazardous gas content of the effluent," as recited in the claim. Krogh and Foster et al. have been discussed above, and do not teach or suggest the exhaust tube and energy applicator.

Aoki does not make up for the deficiencies of Krogh and Foster. As discussed above, Aoki discloses determining an endpoint of an etching process. However, Aoki does not teach or suggest an energy applicator that couples energy to effluent in an exhaust tube that is substantially absent projections or recesses, as in claim 1. Accordingly, claim 1 and the claims depending therefrom are patentable over Krogh, Foster et al. and Aoki.

Claims 11 and 26 are patentable over Krogh, Foster et al. and Aoki because the references do not teach or suggest a computer controller system capable of "determining whether the hazardous gas content of the effluent exceeds a safety level," as recited in the claim. Krogh and Aoki have been discussed above, and do not teach or suggest a controller system that can determine whether the recited safety level has been exceeded. Foster et al. does not teach or suggest monitoring a hazardous gas content in an effluent gas, and also does not teach or suggest determining whether a safety level of a hazardous gas has been exceeded. Accordingly, claims 11 and 26 and the claims depending therefrom are patentable over Krogh, Foster et al. and Aoki.

Claim 24, from which claims 64 and 65 depend, is patentable over Krogh, Foster et al. and Aoki because the references do not teach or suggest "a monocrystalline sapphire exhaust tube through which the effluent may be flowed, the exhaust tube being substantially absent projections or recesses," as recited in the claim. Krogh and Foster et al. have been discussed above, and do not teach or suggest a tube comprising monocrystalline sapphire. Aoki also does not teach or suggest an exhaust tube comprising monocrystalline sapphire. Accordingly, claim 24 and the claims depending therefrom are patentable over Krogh, Foster et al. and Aoki.

Claim 28 is patentable over Krogh, Foster et al. and Aoki because the references do not teach or suggest a computer program product having "safety operational program code adapted to determine whether the hazardous gas content of the effluent exceeds a safety level," as recited in the claim. As discussed above, Krogh, Foster and Aoki do not teach or suggest determining whether a hazardous gas content exceeds a safety level. Accordingly, claim 28 and the claims depending therefrom are patentable over these references.

Krogh, Foster et al. and Maeba et al.

The Examiner rejected claim 32 under 35 U.S.C. 103(a) as being unpatentable over Krogh and Foster et al. in view of U.S. Patent No. 4,816,046 to Maeba et al. This rejection is traversed.

Claim 1, from which claim 32 depends, is patentable over Krogh, Foster et al. and Maeba et al. because the references do not teach or suggest "(d) an exhaust tube through which the effluent may be flowed, the exhaust tube being adapted to provide a non-circuitous and non-turbulent flow of effluent therethrough by being substantially absent projections or recesses (i) that alter the flow direction of the effluent to provide a circuitous flow of effluent through the exhaust tube, and (ii) that cause turbulence in the flow of the effluent through the exhaust tube; and (e) an RF energy applicator to couple RF energy to the effluent in the exhaust tube to reduce the

hazardous gas content of the effluent," as r cited in the claim. Krogh and Foster et al. have been discussed above, and do not teach or suggest an apparatus with an energy applicator that couples energy to gas in an exhaust tube that is substantially absent projections or recesses.

Maeba et al. does not make up for these deficiencies. Maeba et al. discloses that "vessel 1 is formed of an outer wall cylinder 6 and an inner wall cylinder, and a passage 8 is formed between the cylinders 6 and 7" (column 3, lines 50-53), as shown in Figure 1. Thus, Maeba et al. discloses a vessel having an inner cylinder that forms projections and recesses in the vessel that alter the flow direction of the effluent and cause turbulence in the effluent. Thus, as Maeba et al. also fails to disclose an exhaust tube substantially absent projection or recesses into which RF energy is coupled to reduce a hazardous gas content, claim 1 and the claims depending therefrom are patentable over Krogh, Foster et al. and Maeba et al.

Aoki, Krogh and Maeba et al.

The Examiner rejected claims 14, 33, 34, 36, 48 and 73 under 35 U.S.C. 103(a) as being unpatentable over Aoki and Krogh, and further in view of Maeba et al. This rejection is traversed.

Claim 10, from which claim 48 depends, claim 11, from which claims 14, 33 and 34 depend, and claim 26, from which claims 36 and 73 depend, are patentable over Aoki, Krogh and Maeba et al. because the references do not teach or suggest a controller system capable of "determining whether the hazardous gas content of the effluent exceeds a safety level," as recited in the claim. Aoki and Krogh have been discussed above, and do not teach or suggest determining whether a safety level has been exceeded. Maeba et al. does not teach or suggest monitoring a hazardous gas content, and thus also does not teach or suggest determining whether a safety level of the hazardous gas content has been exceeded. Accordingly, claims 10, 11 and 26 and the claims depending therefrom are patentable over Aoki, Krogh and Maeba et al.

CONCLUSION

The above-discussed amendments are believed to place the present application in condition for allowance. Should the Examiner have any questions regarding the above remarks, the Examiner is requested to telephone Applicant's representative at the number listed below.

Respectfully submitted,

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